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ZOOLOGY 10-20

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ACKNOWLEDGEMENT

The Department of Education acknowledges with appreciation the contributions of the following to the preparation of this Senior High School Curriculum Guide for Biology. The Guide has been prepared by the Ad Hoc Committee on Biology. The Committee operated under the guidance of the Senior High School Science Curriculum Committee and the Secondary School Curriculum Board.

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Note: This curriculum guide is a service publication only. The official statement regarding Senior High School Biology is to be found in the Senior High School Program of Studies. The information in the Guide is prescriptive insofar as the content duplicates that given in the Program of Studies.

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PHILOSOPHY AND OBJECTIVES IN RELATION TO BIOLOGY COURSES

A. The understanding of biological principles and processes is paramount. While principles cannot be developed in the absence of supporting facts, the memorization of unwarranted detail is to be avoided. However, mastery of a limited number of technical terms is essential for precise communication. Principles become more meaningful when applied to specific problems. The teaching of structure and function should be correlated throughout the courses.

B. The courses are designed to familiarize the student with his immediate biological world. Every student should be given opportunity to participate in field trips, and adequate facilities must be provided for first-hand laboratory study (see Appendices A and B).

C. The courses should ensure a positive realization of the interdependence of living organisms and the importance of conservation.

D. Three texts have been recommended for use in Biology 10 and 20. Although a preferred text has been indicated for each course, teachers may use any or all of them to develop the units outlined. For the convenience of teachers, page references have been shown for each text. It is expected, however, that professional judgment will determine how each unit will be developed to meet the needs and interests of the students.

LABORATORY WORK IN BIOLOGY

Laboratory work is a vital part of the high school biology program. In order that students obtain maximum value from laboratory experiences these should be done concurrently with the text material. Living plants and animals are valuable in creating an appropriate environment for teaching biology. It is recommended that (1) no experiment using live animals should be attempted unless the animals have clean, comfortable quarters with adequate food and water, and unless humane procedures are followed at all times, and (2) such an experiment should have as a clearly defined objective the teaching of some biological principle which cannot be taught effectively without animals (see Appendix F).

OBJECTIVES OF SECONDARY SCHOOL SCIENCE

The learning of science, as an area of human endeavor, should provide the student with a scientific literacy which enables him to assume an active and useful role as a citizen in a democratic society. It may be assumed that this literacy is best achieved by considering the individual needs of students and through independent study and learning.

The objectives of Secondary School Science are:

1. To promote an understanding of the role that science has had in the development of societies:

   a) history and philosophy of science as part of human history and philosophy

   b) interaction of science and technology

   c) effect of science on health, population growth and distribution, development of resources, communication and transportation, etc.

2. To promote an awareness of the humanistic implications of science:

   a) moral and ethical problems in the use and misuse of science

   b) science for leisure-time activities

3. To develop a critical understanding of those current social problems which have a significant scientific component in terms of their cause and/or their solution:

   a) depletion of natural resources

   b) pollution of water and air

   c) overpopulation

   d) improper use of chemicals

   e) science for the consumer

4. To promote understanding, and development, of skill in the methods used by scientists:

   a) processes in scientific inquiry such as observing, hypothesizing, classifying, experimenting and interpreting data

b) intellectual abilities such as intuition, rational thinking, creativity, and critical thinking

c) skills such as manipulation of materials, communication, solving problems in groups, and leadership

5. To promote assimilation of scientific knowledge:

   a) emphasis on fundamental ideas

   b) relevance of scientific knowledge through inclusion of practical applications

   c) application of mathematics in science

   d) interrelationships between the sciences

   e) open-endedness of science and the tentativeness of scientific knowledge

6. To develop attitudes, interests, values, appreciations, and adjustments similar to those exhibited by scientists at work

7. To contribute to the development of vocational knowledge and skill:

   a) science as a vocation

   b) science as background to technical, professional and other vocations.

GENERAL OBJECTIVES OF HIGH SCHOOL BIOLOGY

1. To enable the student to familiarize himself with his immediate biological world, and to realize the importance of the interdependence of living organisms and the part man plays in this scheme

2. To develop the ability of a student to carry out successful independent study and learning

3. To develop sound procedures for biological field and indoor laboratory study

4. To develop an understanding of and an appreciation for the methods used by scientists; the means and conditions under which science advances; the role of biologists; the importance of accurate and accessible records, constantly improved instruments, and free communication.

BIOLOGY 10

SPECIFIC OBJECTIVES

1. To explore the current critical environmental problems of human over-population and resource management

2. To learn the basic principles of the classification of organisms and the application of these principles in the construction of keys

3. To learn the reasons for and the techniques of collecting and maintaining appropriate biological specimens and to develop an appreciation of the importance of these activities

4. To develop an understanding of the principles of ecology

5. To study the principles of cytology and heredity

RECOMMENDED TEXTS (in order of preference)

1. BSCS Green Version, *High School Biology*, (2nd ed.), Gage, Scarborough, Ontario, 1968. QH 47 A512

2. Otto, J. H. and Towle, A., *Modern Biology*, Holt, Rinehart and Winston, Toronto, 1965.

3. BSCS Yellow Version, *Biological Science; An Inquiry Into Life*, (2nd ed.), Longman, Don Mills, Ontario, 1968.

Note: Laboratory Manual to accompany (3) above is to be used with both *Modern Biology* and the BSCS Yellow Version. The Laboratory program for the BSCS Green Version is included in the text.

TEACHER AND/OR STUDENT REFERENCES

Alberta Department of Education, *Renewable Natural Resources in Alberta*, School Book Branch, Edmonton, 1962.

Benton, A. H., and Werner, W. E., *Manual of Field Biology and Ecology*, McAinsh, Toronto, 1965.

Benton, A. H., and Werner, W. E., *Field Biology and Ecology*, (2nd ed.), McGraw-Hill, Scarborough, Ontario, 1966.

BSCS, *Laboratory Blocks for Biology*, Heath, Toronto.

BSCS, *Reserach Problems in Biology: Investigations for Students*, Series 1-4, Doubleday, Toronto.

BSCS, *Teacher's Guide* for Green Version Text, 1968.

BSCS, *Teacher's Guide* for Yellow Version Text, 1968.

Bullough, W. S., *Practical Invertebrate Anatomy*, (2nd ed.), Macmillan, Toronto, 1958.

Hardy, W. G. (ed.), *Alberta: A Natural History*, (2nd ed.), Hurtig, Edmonton, 1967.

Klinckmann, E., (ed.), BSCS, *Biology Teacher's Handbook*, Wiley, Rexdale, Ontario, 1970.

Morholt, E. et al., *A Sourcebook for the Biological Sciences*, Longman, Don Mills, Ontario, 1966.

Sankey, J., *A Guide to Field Biology*, Longman, Don Mills, Ontario, 1960.

Savile, D. B. O., *Collection and Care of Botanical Specimens*, Canada Dept. Agriculture, Publ. 1113, Information Canada, Ottawa, 1962.

Senior High School Ad Hoc Committee for Biology, Illustrated Keys to Alberta Plants and Animals, School Book Branch, Department of Education, Edmonton, 1969.

_____, *A Bibliography of Conservation and Pollution Materials*, Department of Edmonton, 1970.

COURSE OUTLINE BIOLOGY 10 (READ ACROSS)

NOTE: 1. It is suggested that a minimum of 15% of course time be devoted to each unit.
2. Laboratory Investigations.

It will be noted in the following outline that a substantial number of laboratory exercises have been suggested. Those marked with an asterisk are considered to be basic. Selection from among the others is left to the discretion of the teacher and students.

UNIT I - Student Biology Project

This project will be guided by the teacher but will be selected and carried out by the student (or group of students). The project can be in any area of biology but should involve laboratory and/or field research and the writing of a report. It will be started early, will run concurrently with other units and may continue until the end of the course. (See Appendix D for outlines of sample projects).

UNIT II - Classification	BSCS 1968 GREEN
1. Basis of classification	pp. 104-113, pp. 155-157, Labs 1.1*, 1.3*, 4.1*, 4.2*
2. Collecting	Nil
3. Preserving specimens	Nil
4. How to make and use a key	pp. 782-803, Labs 5.1*, 5.2*
UNIT III - Ecology	
1. Ecosystems and communities	pp. 1-101, Labs 1.2*, 1.4, 1.5*, 2.1*, 2.2*, 2.3*, 3.1*, 3.2*
2. Environmental factors	pp. 214-338, Labs 7.1*, 7.2, 7.3*, 7.4, 8.1*, 8.2*, 8.3, 9.1, 9.2*
3. Interaction	
4. Resource management with emphasis on pollution and conservation	pp. 741-775
UNIT IV - Cell Theory and Genetics	
1. Cell theory	pp. 378, 386, Lab 11.1*
2. Mitosis and meiosis	pp. 393-397, Lab 11.3*, pp. 586-591, Lab 16.2*
3. Mutation and selection	pp. 624-672, all the labs in Ch. 17 and 18, Labs 17.1*, 17.2*, 17.3, 17.4*, 17.5*
4. Selective breeding (plant and animal)	Nil
5. Human overpopulation	pp. 748-752

Modern Biology

OTTO & TOWLE 1965	BSCS 1968 YELLOW
pp. 199-210, Labs 1.1*, 1.2* pp. 744-754, Labs 13.1*, 17.2*, 18.1a*, 19.1*	pp. 348-371, Labs 1.1*, 1.2* pp. 762-819, Labs 13.1*, 17.2*, 18.1a*, 19.1*
pp. 660-670 pp. 672-698 pp. 699-711, Labs 10.1*, 11.2 11.3, 36.1*, 37.1*, 37.2* pp. 712-741	pp. 1-18 pp. 677-733 Labs 10.1*, 11.2, 11.3, 36.1*, 37.1*, 37.2* pp. 734-738, pp. 743-756
pp. 55-69, Labs 2.1*, 3.1*, 3.2*, 3.3* pp. 103-114, Lab 7.1* pp. 116-169, Labs 29.1*, 29.2*, 29.3*, 29.4 pp. 170-181	pp. 38-53, Labs 2.1*, 3.1*, 3.2*, 3.3* pp. 127-146, Lab 7.1* pp. 521-567, Labs 29.1*, 29.2*, 29.3*, 29.4, 30.1, 30.2 pp. 603-606 pp. 738-743

BIOLOGY 20

SPECIFIC OBJECTIVES

1. To investigate further the principles of ecology by carrying out a field or laboratory project

2. To study the theories of biological evolution

3. To show the development and relationship of form and function by comparative study of representatives of the biological kingdoms. The study of man is to be included.

RECOMMENDED TEXTS (in order of preference)

1. BSCS Yellow Version, *Biological Science; An Inquiry Into Life,* (2nd ed.), Longman, Don Mills, Ontario, 1968.

2. Otto, J. H., and Towle, A., *Modern Biology,* Holt, Rinehart and Winston, Toronto, 1965.

3. BSCS Green Version, *High School Biology,* (2nd ed.), Gage, Scarborough, Ontario, 1968.

Note: Laboratory Manual to accompany (1) above, is to be used with both *Modern Biology* and the BSCS Yellow Version. The laboratory program for the BSCS Green Version is included in the text.

TEACHER AND/OR STUDENT REFERENCES

Alberta Department of Education, *Renewable Natural Resources in Alberta,* School Book Branch, Department of Education, Edmonton, 1962.

Senior High School Ad Hoc Committee for Biology, *Illustrated Keys to the Plants and Animals of Alberta,* School Book Branch, Department of Education, Edmonton, 1969.

1. *Key to Tree-Dwelling Lichens of the Praries and Parklands of Alberta*
2. *Key to Aquatic Mollusks of the Prairies and Parklands of Alberta*
3. *Key to the Principal Groups of Insects Occurring in Alberta*
4. *Key to the Amphibians, Fresh Water Invertebrates and Reptiles of Alberta*
5. *Key to the Families of Alberta Fishes*
6. *Key to the Mammals of Alberta*
7. *Key to the Bryophytes of Alberta*

BSCS, *Laboratory Blocks for Biology*, Heath, Toronto.

BSCS, *Research Problems in Biology: Investigations for Students*, Series 1-4, Doubleday, Toronto.

BSCS, *Teacher's Guide* for Green Version text, 1968.

BSCS, *Teacher's Guide* for Yellow Version text, 1968.

Buchsbaum, R., *Animals Without Backbones*, (2 vols.), Longman, Don Mills, Ontario, 1962.

Budd, A. C. and Best, K., *Wild Plants of the Canadian Prairies*, Information Canada, Ottawa.

Bullough, W. S., *Practical Invertebrate Anatomy*, (2nd ed.), Macmillan, Toronto, 1958.

Cronquist, A., *Introductory Botany*, Fitzhenry and Whiteside, Don Mills, Ontario, 1961.

Hardy, W. G. (ed.), *Alberta: A Natural History*, (2nd ed.), Hurtig, Edmonton, 1967.

Morholt, E. et al., *A Sourcebook for the Biological Sciences*, Longman, Don Mills, Ontario, 1966.

Savile, D. B. O., *Collection and Care of Botanical Specimens*, Canada Dept. of Agriculture, Publ. 1113, Information Canada, Ottawa, 1962.

Storer, T. I. and Usinger, R. L., *General Zoology*, (4th ed.), McGraw-Hill, Scarborough, Ontario, 1965.

COURSE OUTLINE BIOLOGY 20 (READ ACROSS)

NOTE: 1. It is suggested that a minimum of 15% of the course time be devoted to each unit.
2. Laboratory Investigations.

It will be noted in the following outline that a substantial number of laboratory exercises have been suggested. Those marked with an asterisk are considered to be basic. Selection from among the others is left to the discretion of the teacher and students.

UNIT I - Student Ecology Project

This project will be guided by the teacher but will be selected and carried out by the student (or group of students). The project can be in any area of ecology but should involve laboratory and/or field research and the writing of a report. It will be started early, will run concurrently with other units and may continue until the end of the course.

UNIT II - Evolutionary Development	BSCS 1968 GREEN
1. Review Unit IV, part 3, of Biology 10.	pp. 624-672
2. The theories of evolution	pp. 673-713, Labs 18.1, 18.2, 18.3
UNIT III - Biological Kingdoms	
The classification, morphology, life cycles and comparative anatomy of selected representatives of the biological kingdoms. The relationship between form and function should be stressed throughout.	pp. 113-213, pp. 591-623 pp. 578-586, Labs 4.3*, 6.1*, 6.2, 6.3*, 16.1, 16.3*

OTTO & TOWLE 1965	BSCS YELLOW
pp. 116-169 pp. 182-209, pp. 542-550, Labs 32.1, 32.2, 32.3, 32.4	pp. 521-567 pp. 568-642, Labs 32.1, 32.2, 32.3, 32.4
pp. 199-210 pp. 211-540, Labs 9.1, 10.2*, 11.1, 12.2*, 13.2*, 14.1*, 14.2*, 14.3, 15.2*, 15.6*, Labs 16.1*, 16.2*, 17.1*, 17.3*, 18.1b*, 18.2*, 18.3, 18.6*, 19.2*, 19.3*, 19.4*, 27.1, 27.2*, 28.1	pp. 177-281, Labs 9.1, 10.2*, 11.1, 12.2*, 13.2*, 14.1*, 14.2*, 14.3, 15.2*, 15.6* pp. 296-371 Labs 16.1*, 16.2*, 17.1*, 17.3*, 18.1b*, 18.2*, 18.3, 18.6*, 19.2*, 19.3*, 19.4*, pp. 458-477, Labs 27.1, 27.2*, 28.1

BIOLOGY 30
(Revised 1972)

SPECIFIC OBJECTIVES

1. To study, with examples from the different biological kingdoms, the following processes:

   a) ingestion and absorption of raw materials, food and gases
   b) movement of materials
   c) elimination and excretion
   d) photosynthesis and other syntheses
   e) digestion
   f) energy relationships including respiration
   g) sensitivity and movement; nervous and hormonal control

2. To provide an opportunity for the study and discussion, in greater depth than in Biology 10, of current biological problems, e.g., pollution, conservation, human overpopulation, space biology

3. To further develop investigative skills and understanding by carrying out a biology project, preferably in the field or laboratory.

RECOMMENDED TEXTS

1. McElroy, W. D., et al., *Foundations of Biology*, Prentice-Hall, Scarborough, Ontario, 1968.

2. Abramoff, P. and Thompson, R. G., *Investigations of Cells and Organisms*, Prentice-Hall, Scarborough, Ontario, 1968.

3. Ehrenfeld, D. W., *Biological Conservation*, Holt, Rinehart and Winston, Toronto, 1970.

TEACHER AND/OR STUDENT REFERENCES

Abramoff, P., and Thompson, R. G., *Teacher's Manual; Investigations of Cells and Organisms*, Prentice-Hall, Scarborough, Ontario, 1969.

DeVos, A. (ed.), *The Pollution Reader*, Harvest House, Montreal, 1968.

Rosengren, J. H., *Foundations of Biology; Teacher's Guide*, Prentice-Hall, Scarborough, Ontario, 1969.

Weisz, P. B., *The Science of Biology*, (3rd ed.), McGraw-Hill, Scarborough, Ontario, 1967.

SUGGESTIONS TO THE TEACHER

1. Organization of the Course

The outline for Unit I as follows indicates an organization which is intended to facilitate the development of the objectives listed on page 12, Specific Objectives of Biology 30, Item 1 (a)-(g) inclusive. However, if teachers wish to depart from this suggested sequence, they should feel free to do so and may present the topics in the sequence which they consider most advantageous to the students.

2. Chemistry Emphasis

Topics 4 and 6 of Unit I of the outline require that students learn a certain amount of basic chemistry for an understanding of the biological concepts involved. The amount, by necessity, must be determined by the teacher. The teacher may well wish to moderate the sophisticated chemistry involved in some of the biological concepts as it is presented in *Foundations of Biology*.

EVALUATION

1. Unit I

Marks for this unit constitute 50% of the student's final mark and will be evaluated by a Departmental Biology 30 "open-book" examination.

2. Units II, III and Labs

Units II, III and labs are not easily evaluated by Departmental Examinations.

These will collectively constitute 50% of the student's final mark and will be assigned by the school.

3. Final Mark

A student's final mark for Biology 30 is computed by the Department of Education by combining the student's Departmental Examination mark with his school mark. These combined marks are reported as one mark.

COURSE OUTLINE BIOLOGY 30

UNIT I. BIOLOGICAL PROCESSES

TOPIC	TEXT REFERENCE (pages)	BASIC LABS
1. Ingestion and absorption of raw materials. (This topic is intended to be an introduction to and review of the physical properties of living things.)		
Physical properties of cells Solutions & colloids Brownian movement Properties of colloids Sol-gel transformations Membrane permeability Osmosis and tonicity	220-226 578	
Active transport, pinocytosis, phagocytosis	226-228	13
Mineral uptake by plants	488-496	
2. Movement of materials in plants and animals		
a) Movement in plants		
Water Turgor pressure Transpiration Transpiration pull	496-498	31
Nutrients TCT theory Root pressure theory Osmotic and diffusion gradients	498-500	

TOPIC	TEXT REFERENCE (pages)	BASIC LABS
b) Movement in animals		
Transport Pressure forces Concentration differences	574-584	
Osmosis Electrical forces and transport Cell membranes and transport		
Circulation Heart and heart muscle Pathway of the blood Blood pressure and blood flow Regulation of blood flow	612-622	33
Blood - the liquid tissue Clotting action Capillary fluid exchange Lymphatic system	624-632	
Antibodies		35
Blood cells and blood types		55
3. Elimination and excretion		
The mechanics of gas exchange in animals (man). Breathing and the respiratory system The role of hemoglobin CO_2 transport Regulation of O_2, CO_2, and hemoglobin content in the blood	634-646	
Elimination of wastes in solution Urea and urine formation Filtration and reabsorption Regulation of the osmotic pressure of body fluids Regulation of body fluid volume	648-658	

TOPIC	TEXT REFERENCE (pages)	BASIC LABS
4. Synthesis of materials		
Chemistry background Role of hydrogen and hydroxyl ion Role of water and carbon	199-203	
Carbon and living materials Carbohydrate compounds Lipids Proteins Nutritional patterns Autotrophs Heterotrophs: aerobic anaerobic	204-216	 15 17 16
Light and photosynthesis Chlorophyll Role of light - conversion of energy levels Factors affecting photosynthesis Production of chlorophyll	258-264	 22 23
Autotrophic nutrition Biochemistry of photosynthesis Raw materials of photosynthesis Photosynthesis: the light reaction; CO_2 fixation	478-488	 19 21
5. Digestion		
Enzymes, coenzymes and inhibitors	228-234	
Food and digestion The gastro-intestinal tract Classes of food Digestive enzymes and their control Absorption and motility	660-671	 24, 25

TOPIC	TEXT REFERENCE (pages)	BASIC LABS
6. Respiration and energy release		
Background	236-240	
Energy transformation		
Enzymes and coenzymes		
Metabolism	240-250	
Fermentation and anaerobic respiration		
Phosphorylation		
Glycolysis		
Energy transfer		
Oxidative metabolism	250-255	28
Fatty acid oxidation		
Amino acid oxidation		
Utilization of energy		
Synthesis - (See Unit I, Topic 4)	265-268	
Vision		
Bioluminescence		
7. Sensitivity and movement, nervous and hormonal control		
Control systems	564-573	38
Hormone control in plants	511-523	
Auxins and tropisms		39
Gibberellins and growth		48b, 49
Cytokinins and other regulators		
Inhibitors		
Plant response to hormone control, light, and temperature		
Kinetics of growth	506-507	
Differentiation of reproductive organs	536-545	48a
Muscular contraction	586-592	

TOPIC	TEXT REFERENCE (pages)	BASIC LABS
Nervous control The nervous system Nerve impulses Sensory receptors Motor reactions Reflex arcs Autonomic nervous system	594-610	
Hormones in man Endocrine system Hormones and glucose balance (liver function) Hormones and growth	672-687 708-722	
Hormone control Anterior pituitary and hypothalamus Hormones and body temperature Hormones and reproduction		
The brain: form and function Ear: structure and function Eye: structure and function	688-706	

Note:

The concepts of DNA and RNA are to be covered in the Biology 10-20 course:

DNA - the master plan
forms and replication

RNA - the working plan
formation and role
genes and enzymes

UNIT II. CURRENT BIOLOGICAL PROBLEMS

The texts *Biological Conservation* by D. Ehrenfeld and *Pollution Reader* by De Vos provide a basic source of information for this unit. Teachers are encouraged to use relevant materials from a variety of other sources. These materials are available from such a wide variety of sources that no comprehensive list can be provided which will remain up-to-date. Teachers are urged to have students make practical application of appropriate aspects of this unit by undertaking related laboratory and/or field studies. Where possible, teachers may wish to invite resource persons to discuss certain aspects of the course.

The earth represents a closed biological system and, as such, space and resources are limited. The following topics may be considered within this framework:

1. Pollution: Causes, Effects, Remedies

    a) Air
    b) Water
    c) Soil
    d) Other - noise, landscape degradation, etc.

2. Conservation

    a) Renewable resources, e.g., wildlife and forests
    b) Non-renewable resources, e.g., water, coal, oil, etc.

3. Human Overpopulation

    a) Biological aspects, e.g., nutrition, disease and population control
    b) Technological aspects, e.g., waste disposal and depletion of natural resources

4. Space Biology

    a) Physiological effects of space travel
    b) Contamination problems

Note:

Topics other than those listed above may be selected.

UNIT III. STUDENT PROJECT

All students are expected to attempt this unit. However, under special circumstances individual students may be excused.

Normally, students will undertake a project in each of Biology 10, 20 and 30. If circumstances warrant, and with teacher approval, a student may be permitted to undertake one project which will extend over two or more high school biology courses.

The student project may be an extension of topics included in Units I and II of this course.

1. Purpose of the Project

   a) To give each student an opportunity to do an in-depth study in an area of his interest

   b) To encourage students to formulate questions for investigative purposes

   c) To further familiarize students with research methods and procedures

   d) To enable students to practice methods of proper scientific reporting

   e) To permit the development of empathy with the scientific researcher

2. Nature of the Project

   a) Normally, the project should go beyond a summary and/or a review of existing literature

   b) The project should be investigative in nature

   c) The project may be carried out by individuals or by groups

3. Developing the Project

The following guidelines are intended (1) to assist students in developing project proposals, and (2) to provide information for teachers:

a) The Project Proposal

In planning their projects, students may be expected to develop statements on such topics as:

i. problem or topic to be investigated
ii. purpose, scope and method of investigation to be used
iii. preliminary lists of references and resources to be used
iv. hypotheses to be tested (if applicable)
v. anticipated time schedule
vi. preliminary list of the equipment and materials to be used
vii. description of any special apparatus required
viii. description of the methods to be used (detailed enough so that the project could be repeated by another student)

b) Guidelines for Teachers

Students should be advised of:

i. teacher expectations re: reports to be made, collections to be made, experiments to be conducted, etc.
ii. amount of school time available for library research, laboratory activities, field work, interviews, etc.
iii. resources available, e.g., equipment, supplies, printed materials, funds, consultative help, etc.
iv. progress reports required
v. evaluation procedures to be used (by the teacher)
vi. final disposition of project (Is the project to remain with the school or the student?)

4. Evaluating the Project

Evaluation of the project might be based on such items as the student's:

a) project proposal
b) methodology and techniques used while carrying out the project
c) written reports, records, and collections
d) oral presentations (to teacher and/or class)

Suggested References

Appendix D and, for additional titles, see Appendix E.

BSCS, *Research Problems in Biology: Investigations for Students*, Series 1-4, Anchor Books, Doubleday, Toronto.

BSCS, *Laboratory Blocks for Biology*, Heath, Toronto. The following titles are of particular interest: *Microbes: Their Growth, Nutrition and Interaction; Evolution; Plant Growth and Development; Animal Growth and Development; Animal Behavior; Genetic Continuity; Field Ecology; Regulation in Plants by Hormones;* and *Life in the Soil.*

Teacher guides are available for the above lab. blocks.

APPENDIX A

SUGGESTIONS REGARDING FIELD TRIPS

It is desirable that every student in every class go on at least one field trip. Numerous difficulties may make this impractical for every school. Each teacher must determine his own limitations because of number of students, transportation problems, timetable and period length as well as the interests of the class and the available regions for a visit. Permission must always be obtained from appropriate authorities--usually the principal. Liability in event of accidents must be clearly understood.

Preparation

1. Teacher must cover the route to check details for pre-briefing of the class.

2. Arrangements with other personnel to assist must be confirmed to avoid confusion.

3. Class should be given an outline of plans in a briefing session.

4. Items of special interest and problems to watch should be listed.

5. Designation of responsibilities for each group should be made.

6. Arrangements for transportation, time of departure and return, and equipment needed should be clearly outlined.

Follow-Up

1. Collected items should be sorted and labelled for future reference.

2. Information gathered should be summarized and distributed.

3. Specimens collected should become the basis for laboratory work:

   a) living specimens kept in an aquarium or terrarium

   b) others may be preserved or mounted

4. Identification of organisms using a simple key is desirable

5. Labelling and mounting of material would be useful so that the specimens could be used for a school museum.

Assessment

Following each field trip, students and teacher should appraise its usefulness.

Immediately on return, the teacher should list necessary revisions of procedure for such trips in the future.

Applied Biology Field Trip Suggestions

1. Experimental Farms
2. District Agriculturist and local fairs
3. Water purification plants and sewage disposal plants
4. Industries, e.g., seed plant

Information Field Trip Suggestions

1. Hospital and clinic
2. Food processing plants
3. Greenhouse
4. University
5. Museum
6. Zoo
7. Aquarium or fish hatchery

Ecology Field Trip Suggestions

1. A wetland area
2. A wooded area
3. A prairie area
4. A vacant lot

APPENDIX B

SUGGESTED OUTLINE FOR A LIMNOLOGICAL STUDY*

Purpose

To acquaint students with some of the living organisms present in a freshwater habitat and to study their existing interrelationships with the environment.

Theory

The waters around us abound in interesting organisms quite suitable for biological laboratory work and special projects. Many organisms can be found in ponds, springs, streams, lakes, and almost any other location that holds water for any length of time. The organisms found reflect environmental differences in salinity, pH, temperature, light, water movement, oxygen content, and a number of other variables. The students will be astonished at the different shapes, brilliance of color, and the elaborate appendages found on many of the specimens. Identification of many species is difficult in that it requires detailed study of a number of morphological characteristics; however, classifying the organisms into large groups is not difficult. When attempting to identify species, students can gain insight into the similarities and differences between them. Students may also gain insight into taxonomic theory and see why some biologists are "lumpers" while others are "splitters".

Materials Needed

Several jars (e.g. 32 oz.) with tight fitting lids
One or two gallon jars for extra water
Dip net(s)
Plankton net
Small collecting vials
Small jars (4 oz.)
Thermometers
Forceps
Labels
5% formaldehyde solution
Notebook

Method

The project may be carried out by a class, a group, or by individuals. Once a suitable freshwater habitat has been located, students may wish to collect samples of organisms by using dip and/or plankton nets. Students should attempt to sample as many different portions of the habitat as possible (e.g. water's surface, bottom, weeds near the shore, etc.). Notes should be kept to determine when and where each sample was obtained, water temperature and movement, turbidity, etc. Organisms caught in the nets should be

* Prepared by K. G. Jacknicke, Faculty of Education, University of Alberta, Edmonton.

transferred to a jar containing water taken from the sample area. Care must be exercised in transferring the organisms, as many are very fragile and easily damaged. It is often possible to invert the net into the mouth of the jar allowing the animals to swim off unharmed. A small amount of aquatic vegetation should be added to each jar to supply oxygen and shelter for the specimens. Care should be taken to keep carnivorous separate from herbivorous individuals.

The jars should be capped for transportation but should be opened immediately upon arrival at their destination.

Extra water should be collected in the large jars for use in sub-culturing specimens for later examination in the classroom or laboratory. Water samples could also be taken at this time for determination of their oxygen content (Needham and Needham, 1962). Students may wish to preserve some specimens for identification and examination purposes by using a 5% solution of formaldehyde.

When the specimens have been transported to the classroom or laboratory, it is often wise to split the cultures so that not too many organisms are in one jar. The best culture methods for maintaining live organisms are those that duplicate the most favorable environment and eliminate natural enemies. Whenever an attempt is being made to culture organisms, a few general conditions should be maintained (Morhold, et al, 1966):

1. relatively constant temperature of 18-21° C.
2. avoidance of fumes of volatile substances
3. approximate neutrality of pH value
4. medium light
5. avoidance of airborne contamination
6. clean glassware

During the investigation of an aquatic environment, it is often wise to obtain a number of mud samples from the area. A mud sample may be obtained from the water's edge or by mixing water with soil taken from a dry slough bottom. Samples should be labelled with date and location and may be stored in jars for later study. The containers may be left open until completely dehydrated, then capped, and retained to start cultures of organisms several months later by adding distilled water.

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APPENDIX C

TESTS RELATED TO POLLUTION*

TEST FOR DISSOLVED OXYGEN

The measurement of the dissolved oxygen content of water is one of the most important tests one can perform to determine whether or not a river or lake is polluted. The amount of dissolved oxygen varies inversely with the temperature of the water.

A good method for accurately determining dissolved oxygen is to use a Hach or La Motte Kit (available from most biological supply houses), but a rather crude qualitative test may be performed as follows:

1. Submerge a sample bottle of approximately 2 fluid oz. capacity (60 c.c.) in the water to be tested.

2. When full of water, carefully remove, and immediately screw top on until ready to test.

3. Perform test by adding ten drops of concentrated manganous sulphate and ten drops of concentrated sodium hydroxide to each water sample.

4. This is a comparative test only. The more oxygen there is in the water the darker brown the sample will become.

   Note: The Winkler Test for dissolved oxygen is very accurate. It is described in many freshwater ecology or environmental pollution study texts.

TEST FOR FREE CARBON DIOXIDE

A low dissolved-oxygen level is usually accompanied by a high carbon dioxide concentration. A carbon dioxide concentration as low as 20 p.p.m. is deadly to many forms of aquatic life. The following is a sensitive and accurate test for p.p.m. of CO_2.

1. Collect the water sample by completely submerging a jar and filling and screwing on the top so that the water is not exposed to the atmosphere.

2. To each 10 ml. of water add one drop of phenolphthalein indicator. A permanent pink color would indicate that no CO_2 is present.

3. If the water remains clear, titrate with 0.0225 M sodium carbonate until the first permanent pink color appears.

4. The level of free CO_2 in p.p.m. is calculated by multiplying by 100 the number of ml. of sodium carbonate used for each 10 ml. of water sample.

DETERGENTS

The Hach Chemical Company of Ames, Iowa, has an excellent kit that will detect from 0-1 p.p.m. of both biodegradable and non-biodegradable detergents.

* Prepared by Dr. N. E. Nichol, St. Mary Composite High School, Edmonton

APPENDIX D

OUTLINES OF SAMPLE PROJECTS

ECOLOGICAL STUDY OF TWO HABITATS*

Purpose

To compare the physical and biological characteristics of two habitats and to observe the factors that enable organisms to live there.

Theory

The term habitat implies a particular kind of environment in which an organism may be found. Such physical characteristics as types of soil, temperature, light conditions, air currents, and available water would limit the organisms that could tolerate a particular environment. Other living things present in the environment of the organism are considered the biological characteristics of the environment.

Method

Select two areas of different topographical nature in which to do the study, e.g., a heavily-wooded area could be compared with an open field, or north-and south-facing slopes could be studied. Procedures that may be followed in doing such studies are outlined in the BSCS Green Version text pp. 76-82, and pp. 98-99. At the conclusion of gathering the data cite evidence that physical factors influence the types of organisms that occupy a habitat. Also consider the ecological relationships found in the study.

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* Prepared by Mr. D. N. Youngstrom, Dr. E. P. Scarlett High School, Calgary.

BARK LICHEN FLORA AND AIR POLLUTION*

Purpose

To discover if urban and industrial air pollution exists in a particular town or city by comparing and contrasting the bark lichen flora of a selected region within the community with that of a similar region from an area thought to be free of pollution.

Theory

Lichens differ from other chlorophyll-bearing land plants in lacking a cuticle layer and thus, when they are wet, they are able to absorb material directly into their bodies. They are particularly sensitive to the pollutants present in gases issuing from settled and industrial areas, e.g., hydrocarbons in exhaust fumes, and are killed or damaged when the concentration of these pollutants is too high. Sulfur, in a variety of forms, is the most harmful airborne pollutant. As one approaches a city there is a gradual restriction of lichens to tree bases, parks and around bodies of water. Fruticose species disappear first, followed by foliose and finally by crustose species. The prevailing wind direction determines the axis and position of the affected area.

Method

Select a grove of trees in each of two areas: (1) an area which is thought to have air pollution; and (2) an area where there is thought to be no or relatively little air pollution. In each case the trees should be of the same species, close to the same age, of approximately the same density, and occupy similar habitats.

Within each grove, at least 10 mature trees should be selected for study. On each tree two areas should be marked off. (1) a band 30 cm. high at the base of the tree; and (2) a band 40 cm. high centered at 1.3 m. from the ground level. Within these two areas all lichens should be located and named, or at least classified as fruticose, foliose, crustose, and squamulose. All doubtful plants should be collected and taken back to the school for identification. The approximate bark area occupied by each species should be recorded by means of the following scale: 1 = up to 5%, 2 = 6 - 25%, 3 = 26-50%, 4 = 51 - 75%, and 5 = 76 - 100%. The data from each of the 10 or more trees of each grove should then be put in tabular form and averages should be computed. The final step is to compare the two sets of data to see if the two areas have different species, compositions and coverages and, if so, the magnitude of the pollution effect.

* Prepared by C. D. Bird, Department of Biology, University of Calgary, Calgary.

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THE ECOLOGY OF FRESH WATER ALGAE*

Purpose

To study types of algae in Alberta ponds, sloughs and streams, and to note adaptations and interrelationships with other life forms.

Note: To adapt this project for winter, one needs merely to break ice and proceed with study.
See also General Objectives No. 1, 2, 3, 4; Specific Objectives for Biology 10: No. 2, 3, 4; Specific Objectives for Biology 20: No. 1.

Materials Needed

Several jars with tight-fitting lids
Plankton or diatom net (see Sankey, p. 63)
Numerous plastic vials with snap-on lids
4% formaldehyde solution
Forceps
Thermometer
Notebook for recording data
Labels or tags

Theory

Different types of algae vary greatly in their tolerance of certain environmental influences such as pressure of current, temperature of water, gases dissolved in water, acidity or alkalinity of water, presence of other organisms, amount of light, and periods of fluctuating water supply.

Suggested Procedure

Students individually or in teams might investigate streams, ponds and sloughs in their vicinity for unicellular algae, filamentous and sheet colonies of algae--noting variations in numbers and types in varied habitats, collecting and preserving for study and identification samples of each type. Collected algae samples in water would be taken in vials, speed of water movement noted, as well as temperature of water, anchorage if any, relative amount of shade or sunlight, signs of fluctuating water level. Sample jars to be filled to capacity with water from each habitat should be capped tightly to be checked later in lab for presence of O_2 and for pH value.

* Prepared by Mrs. J. McCall, F. P. Walshe High School, Fort Macleod.

Life forms associated with the algae (insect larvae, fish, hydra, etc.) should be noted, and collected if desired.

If specimens are taken from tree trunks or damp roofs of buildings, care should be taken that they are not allowed to dry beyond the degree of humidity of their natural habitat. Careful notes of all sources should be kept.

Probably, from each sampling, it would be wise to preserve half of the material as soon as possible, retaining the remainder fresh for study under classroom conditions (4% formaldehyde would be a suitable preservative).

Materials should be sorted and identified as soon as possible after collecting.

Comparisons of results from various collection sources should be made to find out what adaptations led to the success or failure of certain algal types in varied habitats.

Note: Some students might wish to branch out from this project to experiments with maintenance of the collected materials under lab conditions.

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THE SURVIVAL OF SMALL MAMMALS UNDER THE SNOW*

Purposes

To discover the nature of temperature conditions at various levels above and beneath the snow, particularly during days when the air temperatures are quite low.

Theory

Small mammals tend to have high surface-to-volume ratios, i.e., for their size they have a large surface area exposed to the environment. In addition, they are not large enough to grow a heavy coat of fur or to carry it around with them during their normal activities. For these reasons, small mammals are faced with the problem of rapid loss of body heat during cold weather and might well freeze to death unless they can find some means of slowing down the rate of heat loss to their surroundings. Naturally, this rate of heat loss rises sharply as the difference between their normal body temperature and that of their immediate environment becomes greater.

Method

The following investigations should be carried out during cold days when the snow is deep. It is understood that average or mean temperatures are seldom destructive of animal populations; it is the extremes that are critical.

Take the temperature reading in the air, six feet above the snow. Then take the temperature at the surface of the snow and at four-inch intervals as the thermometer is lowered into the snow. Record the reading at the base of the snow and then beneath the loose litter covering the ground. A needle bar or sharp crowbar may be used to probe to greater depths until the students have secured readings below the frost-line.

Graph the results, obtaining a temperature gradient. This will clarify the conditions under which small mammals live at the surface of the ground beneath the snow, as well as the conditions under which others hibernate at greater depths. The investigation should be repeated on different occasions, noting the effects of variations in air temperature and snow cover.

A modification of this investigation might be undertaken in which the readings are secured over and under the snow on the surface of a body of water such as a pond, stream or lake and readings should be taken at ice level, the surface of the water and the bottom of the pond. This would give some appreciation of the environment in which freshwater invertebrates live.

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* Prepared by Dr. C. G. Hampson, Faculty of Education, University of Alberta, Edmonton.

SURVEY OF BEAVER POPULATION*

Purposes

To determine the number of beaver in a community and the location of dams, lodges, feeding areas, and type of food used.

Theory

Beaver control water flow by building dams. Ponds eventually fill with silt and become areas of land suitable for plant growth.

Method

Travel through the selected area and note the location and number of beaver. Observe the size, length, and position of the dams and location of the lodges. Look for "skid-ways" beaver use in hauling branches to the water. What type of vegetation is used? Are any of the lodges abandoned? If so, what appears to be the reason for this? If a large-scale map of the locality is available, indicate on it the exact location of the dams and lodges. If no map is available, then draw one. Prepare a written record of your observations. You may supplement your report with photographs. Include any observations made on the periods of activity, methods of protection, or any other data you have discovered about these animals.

*Prepared by Mr. J. D. Grieve, Jasper Jr.-Sr. High School, Jasper.

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APPENDIX F

GUIDING PRINCIPLES FOR THE CARE OF EXPERIMENTAL ANIMALS

1. Acquisition of Animals

   (a) Only animals raised in the laboratory or obtained in strict compliance with existing local, provincial or federal regulations should be used for experiments.

   (b) Laboratories should purchase experimental animals only from suppliers who maintain adequate records and guarantee the source of such animals.

2. Care of Animals Not Under Experiment

   (a) Animal quarters should be made comfortable by provision for sanitation, protection from the elements and space for exercise. The living quarters should have easily cleaned surfaces, good ventilation and lighting, well regulated temperatures and cages of sufficient size to prevent overcrowding.

   The care and housing of individual species should be in accordance with the recommendations in: *Care of Experimental Animals, A Guide for Canada*, prepared by the Canadian Council on Animal Care.

   (b) Food should be palatable, of sufficient quantity and balance to maintain normal nutrition. Clean drinking water should be available at all times.

   (c) Colonies and quarters should be supervised by a veterinarian or other competent scientist experienced in animal care. The members of the animal house staff should be trained and required to treat animals kindly and provide them with the necessary comforts.

3. Care and Treatment of Animals Under Experiment

   (a) Insofar as the nature of the research permits, experimental animals should be given the same care as animals not under experiment.

   (b) All major operations must be done under general anaesthesia. Minor operations, except injections or drawing of blood from surface vessels, must be done under general or local anaesthesia. If the animal is to survive an operation, proper surgical techniques similar to those used in human surgery must be used; postoperative care should be adequate to minimize discomfort during convalescence in accordance with acceptable hospital

practice and established veterinary surgical procedures. If the animal is not required to survive the operation it must be destroyed humanely while under deep anaesthesia.

(c) If it appears that the experiment has caused severe pain or illness which cannot be adequately controlled, the animal must be destroyed in a humane manner as soon as possible.

(d) When animals are used by students for educational or scientific purposes, such studies must be supervised by a person experienced in animal care and experimentation.

These guiding principles were prepared by the "Committee on Animal Care" of the Canadian Federation of Biological Societies and approved by the Board. They have been approved by the Councils of the Canadian Physiological Society, Pharmacological Society of Canada, Canadian Association of Anatomists, Canadian Biochemical Society, Nutrition Society of Canada, Canadian Society for Cell Biology and the Canadian Society for Immunology. All these bodies recommend that these principles be adopted and followed in Canadian laboratories.

Heads of Departments and directors of laboratories should be knowledgeable concerning the nature of experimentation being conducted in their laboratories and should insist that members of their staff follow these procedures.

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